June 29, 2006

To: **Whom It May Concern**

From: Tim Swedberg
Communication Director, Joint Fire Science Program

Re: **Summarization of Client Issues and Questions**

On behalf of the Joint Fire Science Governing Board, I have spent considerable effort to gather client input. Presentations were made to the following groups and their input on key issues was sought:

- The National Association of State Foresters
- Bureau of Land Management Fuels Managers
- National Fire Administrators Executive Board
- The National Interagency Fuels Coordination Group
- National Wildfire Coordination Group - Fire Environment Working Team and it's four subgroups
- National Weather Service Fire Meteorologists

In addition, a call letter was sent to each agency through their representative on the National Interagency Fuels Coordination Group. I am very pleased with the number of responses and the thoughtfulness of the questions from both meeting with groups and the call letter.

In the following document I have tried to accurately represent the questions and issues as they have been presented to me through various forums. My intent is to give the reader a sense of the needs voiced by fire managers. Also, these items are not prioritized in any fashion. In fact, some of the best ideas are at the end of the list.

It is my hope that the document helps inform the discussion about critical client needs and spurs even further discussion and forums to solve the issues faced by fire and fuel managers across the nation.

If you have any questions please contact me at 208 – 387 – 5865 or email at timothy_swedberg@nifc.blm.gov

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- Fire behavior in live fuels

U.S. Fish and Wildlife Service, Southeastern Region (R-04) Priorities

- At what (quantitative) fuel and climatic condition thresholds do woody wetland fuels (on deep combustible organic soils) cease being a natural barrier to fire spread, and become a significant contributor to that spread and extreme fire behavior?
- What are the most practical means that managers-practitioners can use to monitor and predict when these thresholds will be reached?
- Can we integrate the existing plethora of fire behavior prediction tools and those for predicting and estimating smoke dispersal, emissions and concentrations (and their related impacts on visibility and human health) that are scaleable as to both 3-D space and time intervals?
- Is there any kind of synthesis of scientific knowledge about the process and conditions by which deep organic soils (histosols) ignite and combust? What are the most practical current tools for monitoring those conditions and what new knowledge and tools are in development by which tomorrows managers may more accurately predict and assess when a “peat-fire” is likely to result?
- What’s being done to provide field managers with one-stop-shopping “Fire Depot” from their desks or vehicle to find mission-critical tools, information, data, examples and case studies from.

Decision Support

Item #1: Independent evaluation of wildland fire models and analysis software

Sponsor: **National Interagency Fuels Coordination Committee**

Audience: All wildland fire agencies including State Forester's

Importance: There is a plethora of wildland fire research analysis tools exceeding 140 in number as of this date. Of these tools, few are adopted, certified, integrated with other tools or supported by the federal land management agencies.

Outcome: The National Interagency Fuels Coordinatioin Group (NIFCG) intends to make a management recommendation about which of the available tools should be supported by the interagency community and identify gaps where new tools need to be developed. The potential for cost savings and personnel effort are substantial if a suite of tools can be selected to represent the needs of both state and federal agencies across the nation. If a common set of data can be agreed upon, decisions across the nation would use the same credible information sets. It should be noted that existing tools may need to be completely reengineered for useablility. Learning opportunities would be enhanced with use of standard tools on a common platform.

An essential first step is to independently evaluate and describe these existing tools for their strengths and weaknesses. The examination should include a thorough examination of both commercial and research developed and consider internationally available tools as well.

- What are the specific limitations and assumptions of each model?
- Can the tool provide answers at local, state, regional, and national scales?
- Is the tool integrated with other software?
- What knowledge is required of the user to operate the tool?
- Is there user support and training for the tool? Who & where?
- What data is required to run the tool and is it derived from standard agency information, remotely sensed data, or requires collection from field data?
- Is the tool integrated with Landfire?
- What platform does the tool operate on?
- Is the tool used by state or local cooperators?
- Usability (user-friendly)
- Peer-reviewed or business case study created the tool
- Expandability to meet potential future needs (including interdisciplinary planning and decision support).
- Are there gaps that can be identified where new tools must be designed and built?
- How does this mesh with the efforts of the National Wildfire Coordinating Group IRM Program headed by Judy Crosby and any National Fire Plan efforts?

An Overarching Concern

Will these adopted tools be developed to be run by cadres of experts or engineered to be a common tool similar in form to a 'Microsoft Office' application?

The ultimate suite of recommended and supported tools is dependent on the answer to this question.

A fully functioning suite of tools would also require technical service centers or 'go to experts' to solve complex problems.

Existing tools may be grouped by the following classifications:

1. fire behavior
2. weather
3. smoke management
4. fuels inventory and mapping
5. fire effects
6. monitoring and burn severity
7. economic and risk analysis
8. decision support – go, no go; scheduling; mobilization; prioritization
9. post fire stabilization and rehabilitation
10. administrative reporting and accomplishment
11. data warehouse standards and metadata

RD&A: Commission an independent examination (National Academies of Science, NFPA, NIST, US Fire Administration) validating and describing the software capabilities, gaps, standards, and opportunities to provide fire managers with recommendations for supported fire and fuels software. The examination should also evaluate and recommend web portals/data warehouses for dissemination of information to the fire community.

Decision Support

Item #2 Quantification of Risks – Prioritization for Treatments

Sponsor: **National Interagency Fuels Coordination Committee**

Audience: Agency leadership and Congress

Importance: Without a doubt, the most often asked question is where to place treatments that will make a difference in saving lives, property, and protecting communities. This implies not only an investment for initial treatments, but continuing costs to maintain treatment effectiveness. Leadership is looking for a common methodology across all ownerships nationwide.

Outcome: Nationwide and regional spatial depictions of priority treatment needs backed with costs to achieve the desired results. This item has economic, scheduling, and decision elements. Values at risk may be described in monetary terms, ecological values, or qualitative social values. Characterizing acceptable risk, thresholds, or rules is a desired feature. Descriptors of pre and post treatment risks and the ability to describe treatment effectiveness are important.

Cost Management Analysis Tool
This is closely related and bundled within Quantification of Risks and Prioritization of Treatments. A standard methodology and tool is needed to display cost alternatives throughout the useful life of a fuel treatment project. What are the maintenance costs, how long is a treatment effective, and what is the amortization schedule to maintain the landscape at various risk levels? The bottom line is a display of return on investment in relationship to the values at risk.

RD&A: ***This item may be dependent on the examination of existing software in Item #1, especially Landfire.*** Leadership wants this critical information at a glance, but with a consistent national methodology to compare priorities.

Software tools should provide answers and reports at the national, regional, state, and local levels. The bottom line is to develop a tool that can demonstrate prioritization of effective and efficient hazardous fuel treatments and display the tradeoffs of an array of treatment opportunities.

Decision Support

Issue #3: **How do we optimize opportunities to accomplish more prescribed fire through improved Predictive Services?**

Sponsor: **National Predictive Services Committee – Fire Environment Working Team**

Audience: Agencies charged with accomplishing prescribed fire and fuels reductions through the Healthy Forest Restoration Act and National Fire Plan.

Importance: To take advantage of limited windows of opportunity to increase prescribed fire and other fuel reduction treatments require Predictive Services products that can differentiate between threats and opportunities and clearly display where predicted fuels and weather conditions meet prescription parameters to successfully achieve treatment objectives. Much like the movement of resources to support suppression, a similar system is possible to allocate resources to accomplish fuels treatments.

There is a need to better support RX/WFU fires with fire weather and fuels information that fuels managers can use to both identify areas of opportunity and to be alerted when large-scale weather patterns may present them with control problems. A number of accidents have already occurred this winter/spring (2005/2006) with both wildland and prescribed fires that may have been prevented if there was better oversight, application of "*wind-wizard*" type programs, and alerts for dramatic or abrupt wind gusts/shifts. However, with the forever increasing need for near real-time information, it is becoming more difficult for field level folks to acquire, model, and decipher large amounts of data in a timely manner.

Outcome: Efficient allocation of resources based on prescribed burning windows of opportunity nationwide. This means that resources could be shifted where the most effective effort could be accomplished within defined risks. Could the system be used as a GO – NO GO management tool?

RD&A: Risk analysis and optimization programs need to be developed to support allocation of resources focused on prescribed burning opportunities. (Mike Bevers, Rocky Mountain Research Station started looking at a practical optimization model for pre-positioning fire fighting resources in 2005)

This optimization could be closely tied to Item #2.

Decision Support

Issue #4 How do we quantify the cost savings from proactive resource allocation decisions and establish standardized “draw-down” protocols to determine the number of resources available for preemptive positioning to prevent large fires based on improved Predictive Services capabilities?

Sponsor: **National Predictive Services Committee – Fire Environment Working Team**

Audience: Office of Management and Budget, Congress, and fire management senior leadership**.**

Importance: Cost containment of large (mega) fires is a continuing challenge for all land management agencies. What are the true savings of making smart, proactive resource allocation decisions? How do we quantify the “null event” – The cost savings for the large fire that didn’t occur because of proactive resource allocation? What if we could develop risk analysis tools that would take into consideration the resources needed to prevent a ‘big-one’ by pre-positioning the resources in anticipation of weather and fuel conditions that predictive services estimate will create a high potential for large fire?

Outcome: If a risk analysis tool was developed to prevent large fire development, cost savings may be substantial in comparison with suppression costs for larger fires.
Quantifying the value of strategic decision making would be a valuable output of this process.

RD&A: Develop, test, and validate improved economic and risk analysis models that integrate with existing predictive services tools such as fire spread and characteristics to display the tradeoffs between prepositioning resources to minimize the potential for fires becoming large versus suppression costs on large fires. This question is also an optimizing organizational effectiveness which the military has extensive experience with and may provide lessons learned.

Decision Support

Issue #5: Gaps exist in the accuracy and extent of fire occurrence data nationwide.

Sponsor: **National Predictive Services Committee – Fire Environment Working Team also voiced numerous times by managers at NIFC**

Audience: Fire planners, fire managers, Predictive Services, ecologists, and anyone predicting fire occurrence.

Importance: A cornerstone of planning for prescribed fire, wildland fire use, and wildland fire suppression is an accurate and comprehensive dataset of fire occurrence. Existing datasets are fractured and require multiple queries using differing software that is not integrated to access information. The information is not merely for historical purposes, but ecological and for fire potentials. To run enhanced probabilistic weather forecasts, an accurate fire occurrence database merged with atmospheric historic data is essential.

The State Foresters use fire occurrence as one of the foundation steps in identifying and prioritizing communities at risk from wildfire.

Outcome: An accurate and standardized national fire occurrence database

RD&A: Develop and standardize a national fire occurrence database and reporting system across all landscapes and ownerships that will provide both numerical and spatial outputs and integrate with existing predictive services and land management planning analysis tools.

Test the rigor of existing data and provide statistical descriptors where appropriate.

Develop metadata and integrate with national wildland fire statistics reporting.

Smoke Management

Item #6 Validation of Smoke Models

Sponsor: **National Interagency Fuels Coordination Committee, Fire Environment Working Team, Forest Service Fire and Aviation Management**

Audience: Wildland fire managers and air quality managers at the state and federal levels including the Environmental Protection Agency and ultimately the publics that are impacted by smoke events.

Importance: The limiting factor in prescribed and wildland fire use fires is frequently smoke management issues such as meeting air quality standards, avoiding visibility impairment and minimizing nuisance impacts. There is a pressing need for validation of current models such as BlueSky, but even more important is a GO/NO GO decision support tool that can prioritize smoke impacts as both singular events and allow analysis of cumulative effects over time. Analysis of potential smoke effects from wildland fire use is an important need and needs to be linked with long term fire behavior. The display of effects should be presented in a spatial format much like current weather loops, but specifically for smoke.

Current EPA air quality particulate matter standards are changing and will become more restrictive. Current models for estimating emissions as well as those that estimate particulate matter concentrations are not aligned with these imminent changes. In addition, emission factors for the new $PM_{10-2.5}$ standards are not established for wildland fire.

Outcome: Integrate smoke impacts at local, state, regional and national scales because smoke impacts are now assessed at all of these spatial scales depending on the air quality concern. Fuel models and fire behavior models become integrated with smoke management models. Decision support tools enable decision makers to estimate smoke impacts at local and regional scales considering cumulative effects from multiple fires (prescribed, wildland fire use, and wildfires).

RD&A: Models which can support smoke management decision making are currently not adopted by management and need to become operational systems after thorough evaluation, validation, and testing. A first step would be to develop a set of guidelines and criteria for assessing objectively the performance of smoke and fire behavior models. Since emissions of smoke are controlled by fire behavior and fire intensity, developing an objective evaluation criteria set for both types of models would be best technically and for cost efficiency. Standardized and validated emission factors that meet current standards will be part of these models. Performance standards for the needed fire and air quality management tasks and business functions could then be developed as well. This guideline and performance standards for model evaluation would drive field data requirements and could be applied to a follow-on initiative to gather field data sets to benchmark existing and future models.

As weather and climate forecasting advance, opportunities exists to produce longer time horizon products (beyond 72 hour weather forecasts). If such forecasts can be made, reliability and accuracy may suffer. However, the potential benefits and cost reductions due to better scheduling of fire operations increase with each 24 hour increment of simulation duration. As smoke impacts and wildland fire use incidents extend well beyond the current prediction horizon, what tools should be developed to support decision-making for these situations. Due to rapidly advancing weather and climate simulation science it would be prudent to explore what needs the fire community may have for new tools with a predictive of horizon beyond 72 hours into the future. For example, might an hourly seven day fire danger forecast, explicitly explaining the confidence of the forecast be useful? Would developing a decision tool that prioritizes treatments, assesses impacts and supports actions based on longer term weather forecasts, out to several weeks be useful and achievable? How might research integrating air quality elements with meteorological predictive tools such a chronological ensemble forecasting, improve present and future model accuracy especially for longer-term forecasts? How might seasonal climate predictions be useful for prescribed fire operations and wildland fire use decisions and how far into the future do they need to be made to be so? An assessment what users needs are for longer-term simulations would be timely before technical ability (e.g., ability to make longer-term predictions) becomes the sole driver.

A new tool needs to be developed to visualize smoke impacts across geographic boundaries at local, state, regional and national scales. Such a visualization tool would help us to understand ultra long range impacts and uncertainties. A tool(s) needs to be developed that displays and informs decision makers such as line officers about local smoke impacts and regional cumulative impacts as well. Without such a tool, wildland fire use could be challenged due to smoke impacts and perhaps even halted.

Weather and Atmospheric Sciences

Item #7a: Improved 10-day weather forecasts

Sponsor: **National Interagency Fuels Coordination Committee**

Audience: Fire behavior analysts, fire weather meteorologists, incident commanders and wildland fire use teams, NICC and GACC staff

Importance: If land managers are to rely increasingly on wildland fire use as a cost effective tool to accomplish resource management and fuel reduction objectives, a 10-day forecast is desired. Of greatest concern is the need for improved wind direction, speed, and duration estimates.

Outcome: Forecasts that provide probabilities of events happening much like the severe storms centers produce for hurricanes, but for wildland fire, prescribed burning, and wildland fire use events.

RD&A: Review and summarize existing knowledge of the accuracy of 7-10 day forecasts of non-fire weather (for example hurricane paths, storm systems, or floods).

Issue #7b: Compare and document the strengths, weaknesses and limitations of the forecast systems available for predictive services.

Sponsor: **National Predictive Services Committee – Fire Environment Working Team**

Audience: National Interagency Coordination Center, Geographic Area Coordination Centers, National Weather Service, fire behavior and long-term analysts, and fire and fuel managers nationwide who rely on accurate weather, fuels, and resource decision support information for prescribed burning, wildland fire use, suppression, and all-risk incidents..

Importance: Gridded meteorological forecasts add much detail to predictions of wildland fire weather and fuel moisture information. Unfortunately, there is limited verification or validation methods for these products. Of the existing systems, which one(s) are the most appropriate for wildland fire management? What level of precision is appropriate for wildland fire management uses? It is very important to not only describe the capabilities, but limitations of these predictive tools and integrate them with other fire management processes and/or software.

Outcome: As these systems improve in accuracy and provide more reliable decision support information about fire potential and proactive resource allocation to mitigate impacts, the cost savings for wildland fire and other incident responses may be substantial.

RD&A: Propose or create a process, with standards, for use in comparison and evaluation of meteorological forecast system applications for fire management. This process must include recognition of required field data inputs; the limitations of any systems subjected to evaluation; and recommendations for integration with other fire management systems.

Develop delivery systems that can be accessed in the field (e.g PDA, satellite, etc).

Weather and Atmospheric Sciences

Issue #8: How do we determine ensemble probability and occurrence of Red Flag Warnings and Fire Weather Watches?

Note: **This is closely related to Items #7a and #7b and there may be overlaps that can be addressed within a common question**

Sponsor: **Fire Environment Working Team and National Weather Service meteorologists**

Audience: The National Weather Service and all State, Federal and Local Agencies who make resource and safety decisions based on the NWS Red Flag Warning program.

Importance: Weather forecasting in the past has always been centered toward a deterministic explanation of expected weather conditions. While this is useful, it inevitably leads to subjective accounting for forecast uncertainty. Questions are continually posed from fire management to forecasters such as, "How confident are you that this will happen"? A subjective response follows.

With the advent of probabilistic (ensemble) forecasting, much of this loose and subjective response could be mitigated. For example, a probabilistic representation of Red Flag Warning conditions even on a rough national scale would provide fire management an actual measure of forecast uncertainty. With this measurement of uncertainty, improved and justifiable plans can be developed with a clear understanding of how forecast uncertainty influenced major fire management decisions.

Outcome: Efficient allocation of resources both tactically and strategically. A greatly enhanced ability for fire managers to document fire weather forecast uncertainty. Over time, improved fire fighting cost containment based on scientific risk management, rather than taking action based on one of many possible forecast solutions.

RD&A: Analysis and identification of National Red Flag criteria. Perhaps even a Regional analysis of consistent Red Flag criteria may be appropriate. Engage the FCAMMS and NOAA's Climate Prediction Center to partner in the production of an ensemble approach to Red Flag conditions. Create training material that will equip fire management with an understanding of ensemble products and the aspects of risk management associated with probability.

Weather and Atmospheric Sciences

Issue #9: **How can we improve objective forecasts of lightning occurrence, intensity and ignition efficiency?**

Sponsor: **Fire Environment Working Team and National Weather Service meteorologists**

Audience: National Weather Service Forecast Offices (WFOs), the National Interagency Coordination Center, Geographic Area Coordination Centers, fire behavior analysts and fire and fuel managers nationwide who rely on accurate assessment of natural fire ignitions from lighting.

Importance: Lightning is one of the largest causal factors of fire ignition throughout the United States. Fire Weather Forecasters throughout every Federal, State and Local Agency can predict thunderstorm potential with skill and accuracy. However, determining lightning intensity and efficiency as it relates to fire ignition is one of the greatest current forecast challenges. Current research is being conducted by NOAA's Storm Prediction Center on aspects of this forecast problem. However, partnering with Land Management Agency experts would greatly enhance this effort. Any research that equips forecasts the ability to accurately predict the lighting that is most critical to fire starts would allow extra lead time for movement of resources. This in turn would improve initial attack and enhance IA responders' safety.

Outcome: A greatly enhanced ability to execute proactive resource allocation. Increased Red Flag Warning and Fire Weather Watch lead time, along with improved spatial accuracy. Also, fire management would have new information on the relative severity of upcoming lightning storms for improved situational awareness.

RD&A: Validate and test lightning potential products currently available or under development, such as the forecast scheme developed by NOAA's Storm Prediction Center. Partner with lightning climatology experts from the Desert Research Institute and other fire research groups to determine historical lighting and fire occurrence patterns. Develop a suite of products that provide improved forecast guidance information on lightning's spatial distribution and intensity. This should yield results and provide implementation opportunities in the near term.

Weather and Atmospheric Sciences

Issue #10: **Identify plume growth potential and coupled modeling (National Center for Environmental Prediction)**

Sponsor: **Fire Environment Working Team and National Weather Service meteorologists**

Audience: Fire planners/fire managers, Incident Management teams and NWS IMET'S

Importance: The interaction of a fire and the surrounding atmosphere (weather) plays a major role in determining how a fire will behave. This happens in two ways. First, the wind directly influences the fire by providing oxygen and forcing the fire to spread more quickly in the downwind direction. Second, the fire generates a plume of rising flames, smoke, and firebrands. This plume draws the surrounding air into the fire, blocks the wind, and can contribute to fire spread through spotting. The behavior of a fire along its entire fireline depends on how the rising plume of flames, smoke, and firebrands interact with the background wind.

Current operational fire behavior models are based heavily on many small scale laboratory experiments confined to a wind tunnel and focused on head fire spread. For this reason the influence, on fire behavior, of the rising plume of flames, smoke, and firebrands was not realistically accounted for.

This coupling is especially important for capturing the role of firebrands, rapid changes in fire behavior, and behavior along the entire fireline. Full scale experiments designed to investigate these issues are not likely to occur, due to their complexity, expense, and safety constraints. Models that couple fire and atmosphere dynamics, using present day computers and numerical methods, offer an alternative approach. Such models should be developed with input from targeted reduced scale experiments conducted in the field.

Allow managers and incident management teams a more scientific approach to identify fire days in which plume growth and perhaps even plume collapse would be the main concern.

Outcome: Identify problem days in which plume domination (and/or collapse) was observed or a factor.

Parameterize weather variables that existed during plume domination such as winds aloft, atmospheric instability/dryness and surface humidities (during event and max humidities prior to event). Come up with weather thresholds.

Identify fuel bed characteristics such as depth/fuel type/loading/continuity/ fuel moisture etc. which are prone to creating plume dominated fires.

Identify topography characteristics such as slope/aspect which are prone to create plume dominated fires.

Come up with thresholds which can be created to make an index.

RD&A: Begin to develop plume growth models (a longer term proposition), but deliver the shorter term outcomes listed above. Holding a conference of experts on the issue may be a good way to develop focus and energy for this vital question.

Issue #11 Improve Fire Weather Forecasts though better observation and forecast of vertical distribution moisture in the lowest 300 mb of the atmosphere.

Sponsor: **Fire Environment Working Team and National Weather Service meteorologists**

Audience: Fire planners/fire managers, Incident Management teams and NWS IMET'S

Importance: Moisture is the fuel of the atmosphere; it contributes to all scales of precipitation from severe weather to stratiform rain. It also affects where we experience very low relative humidities (RH) during fires. Yet the National Weather Service has an extremely poor program to observe the vertical distribution of moisture and the numerical models perform even more poorly. While we are investing millions to increase the resolution of the model and improve model physics, the models will be limited until the vertical distribution of moisture is improved. It is suspected that for low RH cases, soil moisture and basic plant evapotranspiration processes also need to be considered.

Outcome: JFSP could convene and sponsor a symposium that would bring together atmospheric and fuels experts to examine the problem of monitoring and modeling low level moisture and build momentum for a focused science based initiative.

RD&A While this is a longer term endeavor, it is important to convene a meeting of experts to examine a future course of action.

Hardly any research and development focuses on how to assess moisture not only at the surface, but also from the surface to about 3000 to 5000 feet up. We are also not aware of any efforts to monitor and predict fuel contributions of moisture to the entire layer of air near the surface. We sometimes get caught off guard when the RH suddenly drops and the fire makes a huge run in a matter of minutes. Yes, there's wind involved in that situation, but there is also RH issues. We simply just don't have a good understanding of the distribution of low level moisture and have a hard time predicting (in some situations) when the RH is going to "crash" or when recoveries are going to be very poor at night.

Biomass

Item #12 Biomass – Focused on Fuel and Fire Interactions

Sponsor: **National Interagency Fuels Coordination Committee and the Interagency Woody Biomass Users Group including agency leadership for this issue, Medford District Oregon BLM**

Audience: Land managers, every field unit in all agencies is grappling with this issue, industry, landowners, Office of Wildland Fire Coordination, Congress, and President Bush

Importance: Managers are challenged to find biomass opportunities as a by-product of fuels treatment activities under energy and Healthy Forests legislation. While the biomass issue has been around for a long time, practical guidance based on credible science information is lacking for practitioners. There is an urgent need for synthesis plus research opportunities especially in the social sciences and the role fuels and fire management play in providing biomass opportunities. Using woody biomass on public lands increases our capacity to do restoration and maintenance work, and to lower the per acre cost from appropriations to get that work done.

- **Energy Policy Act Implementation:** As stated in the General Directives, the implementation of the Energy Policy Act of 2005 and providing access to the public land for energy production are the BLM's highest priorities this Fiscal Year. Work load that supports energy initiatives should be emphasized over other work priorities.
- **Biomass Utilization:** In support of the President's National Energy Policy, the National Fire Plan, and implementation of BLM's Biomass Utilization Strategy (IM 2005-192), BLM will increase biomass offered on mechanical treatments acres in forest and woodlands where land health and restoration treatments and/or fuels reduction treatments are proposed. Biomass utilization efforts funded by Forest Management will be coordinated with those funded by Fire Management.

The importance of the problem can not be overstated. Challenges to increase the utilization of woody biomass are integrally linked with industry capacity, market availability, physical resource constraints, and community/social capacity. Successful utilization across large landscapes rests on the ability to identify and coordinate facilitating policies, grant programs, and to mobilize available industry and community capacity.

Outcome: One outcome might be a guidebook and resource to assist field managers and line officers in state and federal agencies especially considering the viewpoints of fuels managers who must implement biomass policies. A broader approach that reexamines institutional constraints, enabling policies, target acre treatments, grant programs, pressure to recoup costs of treatment prior to market stabilization, and a reluctant private industry to deliver public goods (via restoration of forests and protection of ecosystem services) based on uncertain returns may yield lasting results.

RD&A: *Note: I gathered a bunch of information about biomass – it is truly a hot topic! At the end of this section I also sought the input from scientists about operational and implementation questions.* ***My apologies for the length.***

Synthesize the state-of-the-art knowledge about biomass from wildland fuels. Included would be success stories, failures, new uses, equipment, market analysis, market development, incentives for investments, estimates of available resources and relationship to existing industry. Some of this work has already begun, but additional resources could produce a more comprehensive field book.

Investigate public attitudes about woody biomass for energy and other uses with a special focus on environmental groups.

Development of any technology that assists with understanding sustainability issues around supply and economics of different in-woods and transportation technologies is another area of investigation.

What is the role of business infrastructure in building the capability to sustain the environmental balance of biomass use? What is the risk of "boom and bust" cycle of biomass utilization businesses?

What barriers are in the public and commercial loan areas to finance and support actions?

What risk in the development of biomass use could be damaging to the environment through well intended federal policy that causes inappropriate expansion in fragile lands?

What is the length of time necessary for a healthy business infrastructure to develop which supports forest restoration work?

Are federal land management policies helping, hurting, or causing the business landscape to change that prevent or limit private investments? What role can and should community groups play in the development and long term sustainability of a viable biomass utilization business sector?

Is there some way we can increase the utilization of excess hazardous fuels in lieu of burning?

Biomass generation plants filter 97% of the particulates from woody debris while prescribe burning or pile burning does not. With potentially greater restrictions on release of coarse emissions, what are the tradeoffs of the following treatments in regards to reducing hazardsous fuels and particularly the submerchantable material 1"-7" DBH.?

- Commercial harvesting the sawlogs and concurrently thinning and removing the submerchantable material **all in one operation**. (Case study: The Lassen National Forest has been successfully implementing this one-entry operation for years. One of the reasons for their success is because they have the biomass plants (infrastructure) to successfully utilize the material.)
- Commercial harvesting the sawlogs followed by a prescribe underburn
- Commercial harvesting the sawlogs followed by a slash busting operation and a prescibe burn
- Commercial harvesting the sawlogs followed by a slash busting only operation.

How does slash busting/mastication impact the nutrient cycling in the soils by the addition of layers of organic material?

What if we started looking at smaller utilization facilities or outlets like fuels for schools to serve as outlets for utilizing excess fuels? Instead of large 10+ megawatt plants, maybe we should look at smaller facilities that require less demand or supply energy just for a community.

Could you determine the impacts of cutting and yarding western juniper from juniper woodlands versus the impacts of cutting, piling, and burning? (Need to take into consideration burning costs, impacts to native vegeation from the yarding, % of the vegetation disturbed, how long it takes for the native vegetation to return to the skid trails after treatment, etc... In eastern Oregon districts and northern Callifornia, there is more and more emphasis on utilization of the western juniper in lieu of burning. Much of the interest is from the public. Little to no research done on the impacts of utilizing this material in lieu of burning. Resource specialists are concerned that the yarding removes some of the native vegetation and there is a increase of cheat grasss for 10-15 years until the native vegetation has time to seed the trails in.)

What is the potential for immediate reseeding of disturbed areas with native seed? Is there sufficient local seed available? Can we collect it native seed, store it, and reseed successfully to reduce the impacts of yarding western juniper?

There is a need for understanding the social environment of communities to accept biomass as part of resource management and to develop case studies and best methods to engage communities in long-term sustainable biomass projects. (The Apache-Sitgraves Stewardship Contract is a wonderful example of integration between the agencies and the communities. It took a 400,000+ acre fire to do this. What can we learn from that successful integrated contract? (Programs are so target and funding driven that there is little time to meet with communities to develop an integrated solution to investigate new ways of doing things. We tend to still be in the reactionary mode waiting for solutions to catch up to our treaments. What I mean is that we continue to implement our standard treatments that we have always done without trying newer ones. The treatments are successful and hazardous fuels are reduced, but time and targets are not allowing us to get more engaged with the communities.)

What is the trade-off between leaving standing dead and down wood remaining on a site and the benefits from the dead wood?

What are the “thresholds” for dead wood that move significantly the affects on fire behavior --- moving it out of the range of control by ground personnel. At what point is the risk of fire going to offset the positive benefits derived from leaving more dead wood on the site? Information would be very beneficial if studied by Plant Association or at least by Plant Series giving the moisture regime (Moist/gentle slope or Steep slope/dry) and/or by elevation. This issue causes strife between resource managers all wanting to “maximize” the good effects of their resource but without full knowledge of the interaction with other resources and the consequences of leaving more. The public has these same concerns and it guides many of our projects.

How does harvesting affect fire behavior (regeneration logging)?
What are the long and short term effects of these prescriptions and treatments?
What can social science research provide to help design treatments acceptable to the public?
More…
I represent fire/fuels in all our ID team meetings. I have found and I think most fuels managers would agree that proposed fuels reduction work which includes thinning of vegetation less than 8 inches in diameter does not raise a red flag with the "public" entities. However, as soon as commercial harvest is brought into the picture, especially commercially thinning (this includes all forms of harvesting; regen, density management etc.) that is implemented or planned for reducing the fuel/fire hazard, the public thinks we are pulling the "wool" over their eyes and using fuels hazard reduction as an excuse to log. I realize that there is some research on how commercial harvesting has affected fire behavior, but it is limited, this is especially true for regeneration logging and for the dry conifer types found here in SW Oregon. I think there are long and short term effects that really need to be looked at. If we thin the canopy bulk densities and follow through with slash treatments are we really decreasing the fire behavior, and if so, to what extent based on treatments.

Evaluation of Program and Project Effectiveness

To build on and replicate successful projects and utilization programs around the country, it is critical to understand the factors that lead to progress. An evaluation of wood utilization projects and strategies is necessary to isolate key community characteristics, institutional mechanisms, and effective investment strategies.

- Evaluate the effectiveness of utilization and marketing investment programs and strategies employed by federal, state, and local governments.
- How effective, from a cost-output investment perspective, are cost-share programs, tax incentives and other policy instruments in stimulating private investment in biomass utilization?
- How do service contracts, stewardship, and timber sale bid amounts vary across forests and proximity to the wildland-urban interface?
- What is the location of fuel treatments relative to the cost of treatments and prioritization? How do these factors influence resource availability and profitability of utilization enterprises?
- How can adaptive management/monitoring programs be instituted to facilitate transparency in fuels reduction efforts while enhancing utilization programs? What policy mechanisms are necessary to achieve effective adaptive management?
- What is the role of government and agencies in providing resources for investment in utilization technology? How are limited resources best allocated?

Barriers to Investment in Private Sector Bio-based Products and Energy Infrastructure

Much is made of the need to find new markets for the utilization of a new suite of forest resources from fuels reduction efforts. What requires more focus is the policy context within which incentives are provided and barriers to market development are lifted. There is a need to analyze comprehensively the economic and social impacts of policies that affect our ability to envision, design, and implement appropriate land management decisions.

- What are the drivers of private investment that are linked to public land and resource management activities, including fuels reduction planning?
- What are the benefits and costs, and lessons learned from existing federal and state programs and policies aimed at stimulating private investment in wood utilization processing, manufacturing, product development, and consumer behavior?
- Are new contract authorities successful in stimulating markets for woody biomass, and do they provide enough assurances to investors and financers?
- What types of policy instruments (tax incentives, cost-share programs, investment in research and development, and technical assistance) are most appropriate to stimulate increased utilization of woody biomass and who should those strategies target (harvesters, transportation, manufactures, research, and consumers)?

Community and Industry Capacity

Because much of the fuels reduction thinning requires the work of community initiatives and private business to be successful, a comparable degree of industry and social capacity is needed within communities. This capacity will need to be built in most communities. This social science research is aimed at identifying the types of capacity necessary to affect forest restoration and replicating those attributes where treatments are prioritized.

- Which communities are capable of effectively using federal dollars to affect landscape level treatments? What community characteristics enable partners to come together for success?
- Determine the effectiveness of different types of capacities to facilitate forest treatments that can be used to develop capacity-building strategies in different types of communities. What type(s) of community capacities (skills, investment, business planning, marketing) for which stakeholders (community partners, private businesses, forest managers) are necessary to capitalize on utilization needs?
- Which communities have the capacity/ability to invest in utilization technology? Which indicators and measures are most appropriate for assessing the capacity of communities to engage opportunities related to utilization and wildfire preparedness?
- Evaluate the role that institutional barriers and opportunities play in resource management policymaking and implementation pertaining to wood utilization and community development.
- Synthesize knowledge of community and institutional capacities for collaboration and incorporate this knowledge in building capacity to affect utilization.

Resource Characterization & Planning

The issues that guide wood utilization and resource characterization research topics are broad. They range from physical characteristics of the forest resource, existing harvesting and processing infrastructure, skills available in a community, location of the forest resource, and design of management activities; all interact to create utilization options uniquely matched to the scope of the issue and the scale of required treatments. The interaction and integration of these issues with social science components are critical for success.

- How will a focus on utilization and forest restoration affect future stand characteristics and subsequently implications to rural community livelihoods?
- Improve understanding of how differences in resource characteristics influence small-diameter wood utilization options in different types of communities.
- Assess the types of utilization options that are most suitable for forest-based communities given the physical characteristics and distance to the resource supply, workforce skills, and community capacities.
- Evaluate the effectiveness of various wood utilization projects by region and strategies to facilitate forest restoration and sustainable community development.
- Incorporate knowledge from evaluation studies in the development of regional/ national utilization strategies to the extent that they facilitate progress.

Collaborative Planning

A broad range of public interest groups and individuals increasingly see their prerogative to participate in shaping the very questions and assumptions made in land management decisions. It is increasingly used by community forestry groups in conjunction with federal and state agencies to facilitate development of wildfire protection plans. The primary goal then is to determine how collaborative planning may be used to facilitate development of wildfire protection plans, biomass utilization, community development, and social acceptance. Collaborative planning can be used for each purpose or collectively to coordinate a fuels reduction strategy.

- What are agency expectations for collaboration? What are the incentives and disincentives to participate in community-level collaborative planning and management?
- In what situations (forest planning, prescriptions, monitoring) is collaborative planning most effectively used to facilitate wood utilization and private investment?
- What institutional mechanisms are available and necessary to facilitate collaboration for types of treatments implemented, location of treatments, and social-biophysical monitoring?
- Evaluate how collaborative planning may be used in designing forest treatments, implement projects, and monitor project impacts.
- How can collaborative planning be used to implement effective adaptive management processes.

Impacts of Fuels Reduction Efforts

Management actions to restore conditions over extensive areas could include treating stands with considerably different characteristics. Variation in forest conditions and in treatments applied implies variation in the quality of wood generated, associated product opportunities, economic feasibility, and community development impacts.

- Assess and monitor the social and economic impacts of forest restoration programs and the effects of new small-diameter processing on forest-based communities in terms of job development, wildfire protection, and subsequent public acceptance.
- What types of utilization are most appropriate for stable community employment and livelihoods? Do fuels reduction efforts benefit local contractors and community businesses?
- Develop baseline data on the enhanced value of ecosystem services and economic benefits of fuels reduction programs and avoided costs of wildfire risk reduction/ resource protection.
- Compare the economic and social impacts of wildfire events to impacts from fuels reduction programs. Determine how the well-being of forest-based communities (jobs, economic development, recreation opportunities, tourism) are affected by changing forest conditions (structure and function) resulting from management actions and natural disturbances.
- Improve understanding of how forest-based communities perceive natural disturbances (including wildfire and insect epidemics), and how it shapes their reaction to and engagement in the planning processes (e.g., wildfire preparedness).
- Continue to measure social acceptance of fire, prescribed burning, smoke management, fuels reduction techniques, and other activities associated with forest restoration treatments.

Remote Sensing

Issue #13 **Live fuel moisture is an important variable in predicting fire behavior. Can research provide a method and system to provide this critical information to fire and fuel managers nationwide?**

Sponsor: **National Predictive Services Committee – Fire Environment Working Team; Wildland Fire Use Workshop, Region 6/Oregon BLM fuels staff;**

Audience: Fire and fuel managers nationwide across agencies

Importance: Live fuel moisture is a critical component of fire behavior analysis. There is no standard method for collecting this information. What information is gathered relies on fire crews who are often engaged in suppression work, so there is a need for an answer remotely sensed. The thresholds must work for not only forested areas, but rangelands. This information is also a key component in weather and atmospheric questions.

Outcome: A consistent remote sensing method and ground validation method protocol to gather this critical information.

RD&A: Develop a standardized method, validate with ground sampling, and synthesize the existing state-of-the-art and determine opportunities for improvements -- especially remote sensing methods.

Fire Behavior

Item #1 4 Fire Behavior Curriculum Development

Sponsor: **NWCG Fire Environment Working Team – Fire Behavior Committee**

Audience: Wildland Fire Community

Importance: In the wildland fire community, the fire weather/danger/behavior curriculum is the most robust and far reaching when compared to any other subject area. No fewer than 9 major training packages deal with the subject. Many of these incorporate both distance and classroom components. Beyond these, a number of ancillary leadership training packages such as Prescribed Fire Burn Boss and a number of other management programs such as FPA and LANDFIRE draw upon this subject area.

Yet, there is a great deal of evidence that this existing system is not as successful as it needs to be. Review after review of unsuccessful efforts in management on the fireline point to critical gaps in knowledge and understanding.

The existing system needs to be redesigned to insure that concepts are:

- learned,
- retained,
- and built upon effectively.

In addition, it needs to:

- accommodate the fast pace of change in both knowledge and application.
- recognize the roles of experts, a widely distributed instructor base, and fireline decision-makers.
- incorporate educational concepts aimed at insuring effective adult education such as continuous life-long learning opportunities.

Outcome: From all research endeavors, the ultimate outcome is greater understanding and to pass that information, knowledge, and ultimately wisdom to those who will make decisions or put the knowledge into practice.

RD&A: This item is focused on new systems that could be employed to teach fire behavior information that is produced through research and that firefighter lives depend on. At this time, it would appear that if a standardized suite of software could be recommended, issues such as this, which involve technology transfer through education, could be focused and delivered with greater effect.

Fire Behavior

Item #15 Extreme Fire Behavior Synthesis

Sponsor: **NWCG Fire Environment Working Team – Fire Behavior Committee and the California Department of Forestry and Fire Protection**

Audience: Wildland Fire Community

Importance: We continue to experience near miss accidents and fatalities on the fires. How often have we heard the reports stating ‘a sudden unexpected change in the wind’ as a causal agent? Recent discussions among experts, instructors, and users make it clear that, only with great uncertainty, are the location and timing of rare fire events predictable. Much has been written over many years on the subject, with many of the conclusions subsequently invalidated.

These incidents tend to be reviewed on a case by case basis, each being investigated independently. It would be productive and instructive to collect these reports from across the several wildland fire agencies and study them for common denominators relating to weather and firefighter's understanding of fire behavior. The analysis should focus on the Fire Weather business process. Why is weather such a surprise that fire fighters are getting hurt and what needs to be fixed in the business process (forecasting?, communication?, spatial resolution?, temporal resolution?, training? Other?).

Outcome: It is time to bring together the current state of knowledge into a resource that can be used by instructors and field practitioners in all agencies and jurisdictions.

Further, this knowledge base should serve to identify the needs for future exploration and examination to improve not only the subjective understanding but models for prediction. Before we fix future weather systems, it seems prudent to understand the weather system failings and weakness before new systems become operational.

RD&A: Extreme Fire Behavior – Common Denominators – Synthesis Research
This question could be an initial building block for related weather conditions as well.
Similar summarization efforts have been well received by the fire community and used as a change agent to help prevent accidents.

Historical Fire Regimes and Stand Densities

Item #16 Ponderosa pine – Douglas-fir restoration

Sponsor: **BLM Colorado**

Audience: Foresters, silviculturalists, fire planners and ecologists, NEPA specialists and planning staffs

Importance: There is a lack of data regarding historical fire regimes and historic stand densities (when I say historic I mean pre-European American settlement) in dry mixed conifer forests such as ponderosa pine/Douglas-fir forest types. Since "Forest Restoration" is such a hot topic these days, it would be useful to have some information regarding historic conditions in forest types other than pure ponderosa pine.

Outcome: Perhaps a few different studies could be conducted in different areas throughout the western U.S. for comparison's sake. Information regarding this topic would be very helpful to me and other implementers when preparing our NEPA documents, implementation prescriptions, etc.

RD&A: This is an excellent question and points to the need that summarizations of information are desperately needed by field practitioners. In fact, a similar question was asked by JFSP in 2006, but was not focused on Ponderosa pine/Douglas-fir forest types.

What is missing in synthesis work is a dedicated electronically skilled research librarian that can organize information. Then cadres of experts can prioritize the works as significant contributions and science writers can provide overviews and invitations to explore the issue in greater depth. From that we can build high quality digital information delivery systems because no one has time to sift all the information available. What the research and knowledge transfer goal should be is to deliver the best information that will help inform decision-making.

Prescribed Fire

Item #17: Ponderosa Pine Mortality from Underburning in Deep Duff

Sponsor: **Silviculturalists in the BLM and Forest Service in Idaho, Washington, and Oregon**

Audience: Anyone interested in restoration of ponderosa pine

Importance: This is a classic example where some scientific information is available (Agee, Crater Lake Studies), but large diameter ponderosa pine continue to die from underburning in spite of the best pre-burn efforts and silvicultural prescriptions. This topic is definitely a big issue as we received over 12 separate emails in response to our call letter for input. This is an on-the-ground issue that Russ Graham is investigating through a JFSP-funded project on the Boise Basin Experimental Forest. Russ has some answers and we are trying to get everyone together for an initial conference call.

Outcome: Answers that will help protect the large diameter trees (from any species) from fire.

RD&A: Topics such as this could be outstanding examples for technology transfer. What is the best way for the user community to receive the information? When do they need the information? What strategy and tactics do you employ to increase:

- **Awareness**
- **Comprehension**
- **Conviction**
- **Commitment**

Great Basin Rangeland and Desert Ecosystems

Note: I tried to summarize similar issues for these geographic areas, but they involve prescribed fire, invasives, burn severity remote sensing and monitoring, and restoration of arid land ecosystems.

Item #18 Great Basin Issues

Sponsor: Utah State Forester, BLM Washington Office, BLM Utah State Fire Managers, Park Service units in the Mojave

Audience: Arid lands managers

Importance: The sagebrush biome encompasses over 100 million acres. Over the last 150 years, there have been profound ecosystem changes with the invasion by cheatgrass, red brome, and woodland species such as pinyon pine and western juniper. In 2005 over 2 million acres burned in arid lands and 2005 set a record of over 8.5 million acres burned nationwide, surpassing the 2000 fire season. Restoration after these fires is a major concern for BLM resource managers.

Restoration research needs are focused on sagebrush. Over $19 million is spent annually for restoration activities, yet restoration success is not satisfactory.

In the Mojave Desert, Senator Reid, Nevada, is very interested in fire research with respect to invasives such as red brome.

Outcome: Comprehensive research focused on arid lands providing best state-of-the-art guidance.

RD&A: It is clear that although we have embarked on the Sage Steppe project, a focused communication plan for this region, targeting managers and field practitioners, is needed. While the project may be known, it is not apparently associated with JFSP.

To restore sagebrush, investigate survival and establishment rates from seed versus seedlings. Put simply, research needs to find a way to improve sagebrush reestablishment. This effort should not be limited to sagebrush, but all native species in the Great Basin or arid lands.

Develop a comprehensive Great Basin Restoration Guidebook on when to seed, how to seed and to what depth that will lead to successful restoration.

Validate FEAT/FIREMON on sagebrush steppe burns.

Investigate the relationships and policy implications between cattle grazing and restoration following fires.

Conservation assessments for sage grouse (knowledge gaps)

Investigation and validation of wildland fire use for sage grouse habitat.

Long term soil and other impacts from mastification (Bull hog type chipping) treatments.

Fire interactions in Pinyon-Juniper Ecosystems and cheat grass and fire

Social Science Questions

Item #19 Firewise Program

Sponsor: National Fire Protection Association, Bureau of Land Management

1. How much fire ecology information is necessary before residents are willing to do mitigation? Does a resident need to know about the historical significance and scientific basis for fire on the land before he/she accepts or acts on mitigation recommendations? By analogy, how much should a person know about hydrology before they understand flood mitigation?

2. The American Planning Association research showed that the majority of 1999-2001 Firewise Workshop participants actually used and/or acted on the information they received in the workshops in a period of 6-18 months following the workshop. We would like to complete the study with those who attended 2002-04 workshops. The survey model is available but there might be others.

3. Incentives for mitigation – what kind of incentives work best (financial, social, moral)? When and under what circumstances? Is there a process model for developing incentives and evaluating them before and after their application? What makes one incentive more preferable? Does the prospect of lower (or higher) insurance premium payments for interface residents result in more (less or different) mitigation than other incentives? How do incentives affect different social strata in the interface? Does the same incentive work for residents and response personnel? What incentives affect mitigation/change in fire personnel (not all do as they instruct others to do)?

4. What community CC&Rs preclude effective mitigation? For instance, some communities' covenants prohibit the cutting and/or removal of any vegetation (dead or alive) or noncombustible roofing. What would a model residential landscape (with the home ignition zone) look like and what might be effective incentives for homeowner associations to accept or modify their restrictions?

5. What are the key human behaviors in community evacuation? What can we learn from the New Orleans experience? Tom Cova (Univ of Utah) did a study on evacuation in the Oct03 fires in So CA, Dr John Bryan (Univ of MD) conducted several studies on human behavior in evacuation, etc. What do we know about human behavior under extreme evacuation circumstances and how might we apply that knowledge in the future designs of Firewise Communities (recommending the establishment of a central safety zone within the subdivision, etc.)?

6. What information in regards to the Firewise concepts and mitigation practices are of value to younger audiences (school education)? How much, what, and at what ages? This would help us design education programs for school teachers in appropriate grades for the next generation of interface residents.

7. Technology transfer of existing research needs to be assembled and delivered to clients. Where is the application phase of this research? There should be some mechanism to provide guidance on applying this really good research. We should be able to synthesize and promote the social research and provide those on the ground with key factors to consider when speaking about mitigation, working with interface residents, etc.

8. Given that when people understand there is something they can do they are more willing to act and that they consistently search out information to validate what they have heard (Natural Hazards Informer, 11/99), what are the most effective actions public agencies can take in supporting both a community's knowledge search and its decision to act? Once these actions are identified, how can they be effectively implemented at the federal, state, and local levels? The recognition program has some excellent success

stories in the area of public agency involvement. These could be reviewed and documented. Conversely, it has met with lack of interest in some quarters. I would like to see that issue explored as well, with an eye to identifying ways to overcome agency stumbling blocks.

9. Why does it seem southeastern states adopting USA more readily/successfully? Is it cultural, social, economic, historical, geographic (regarding how land in the east was originally plotted/developed vs how the west was plotted/developed), or a combination?

10. How can we more effectively measure the impacts of the Firewise program, including economic costs and benefits?

More…
From BLM employees who work in community assistance, fire education, and fire prevention fields.

Most of my job is communicating to various audiences - internal and external - and I need help to identify what is most effective for which type of audience; and how can I measure the success of the programs.

How do I measure fires prevented? How do I measure the number of homes saved because of the outreach efforts? If we go into an area and do a series of prevention/mitigation/education projects and there are no fires, can we take credit for saving all the homes in that community?

What metrics, standards, or outcomes are reasonable measures of success in mitigation/education/prevention programs?

These questions are gaining in importance as we move towards FPA where mitigation/education projects will be balanced with operations, fuels and other programs for scarce dollars.

Adaptive Management and Climate Change

Item #20 Silvicultural management strategies for non-constant climatic regimes

Sponsor: **Okanagan National and Wenatchee National Forests, Region 6**

Audience: Silviculturalists and forest planners

Importance: The implications of climate on forest, shrub, and grass dominated communities are profound.

Outcome: "It seems like we know enough now to be confident 'times are a changing'. It would be helpful to have some tools so we can understand which way to jump."

RD& A: What are the implications for management according to different forest types and fuel types?

What are the disturbance regimes and agents that might be dominant or influential in forest and non-forest vegetation types under postulated climates?

How sensitive are the species compositions and structures to differing climatic regimes (warmer - dryer; warmer - moister; etc.)?

What vegetation structures, fuel structures, etc. are likely to mediate rapid change, and to what degree would the mediation occur under different climate regime scenarios?

What vegetation structures (vertical and horizontal layering), densities, fuels structures, arrangements, landscapes and patterns, species assemblanges, and so forth are less susceptible to climatic flux, which are more susceptible?

What are the real world implications for managers in terms of wildland fire behavior and WUI management?

How will insects and plant diseases possibly respond to climate, and to the structures/assemblages wildlife habitat, watershed integrity, runoff, etc?

What is the literature base, and how is it best interpreted by managers and practitioners in a proactive and useful manner?

What SIMPLE!!! and easily used decision tools can be constructed for managers and resource professionals to aid in assessing the utility of management practices in terms of landscape resilience to climatic flux induced perturbances?

Invasives

Item #21 Invasive grasses in the Dakotas

Sponsor: **Huron Wetland Management District South Dakota and Federal Agencies, Fish and Wildlife Service**

Audience: Fish and Wildlife Service

Importance: The USFWS in the Dakotas is currently in the initial steps of developing a Dakota-wide, cross-refuge research initiative to look at the best tools for suppressing smooth brome.

Outcome: Practical management guidance

RD&A: How can fire be used as a prescribed treatment to combat non-native grasses, particularly smooth brome and Kentucky bluegrass.

Cultural and Tribal Resources

Item #22: Examining human agency in past fire regimes and implications for modern management, including restoration regimes.

Sponsor: **Agency cultural and tribal leaders**

Audience: All fire ecologists and managers that are concerned with analyzing past fire regimes, identifying historic reference conditions, and defining restoration goals.

Importance: Fire histories often neglect to factor in human agency in the use of fire to promote certain landscape conditions. While it is generally recognized that indigenous societies used fire to manage landscapes of interest to them, fire histories are generally presented as "natural fire regimes". Questions are framed as follows:

> "Land managers are asked to restore land to historical conditions, yet there is little or no information available about past natural fire regimes…As managers attempt to mimic natural cycles, this critical information is a necessary first step in the restoration process." (Joint Fire Science Program 2005 Progress Report, p. 8)

When models for future restoration are based on analyses of historic reference conditions that ignore human agency as a factor in the development of those conditions, these run the serious risk of being based on data that not entirely correct. That is, if the landscape effects that are defined as "historic reference conditions" are attributed solely to natural causes, then our restoration remedies will seek to rely on or mimic those natural causes which are thought to be responsible for those desired conditions. If human agency was a factor, and we do not account for it, we will be basing our restoration actions on a biased view of the evolution of particular landscapes.

Archaeological evidence can and does contribute to understanding both the nature and condition of historic landscapes and the role of previous societies in affecting and maintaining them. Site location (antelope fences which follow the edges of juniper woodlands); artifact data such as burned hydration rinds on obsidian artifacts; and various other types of studies contribute to understanding human use of the landscape and help reconstruct past environments. Because of the close relationship of native peoples to the natural environment, archaeologists routinely use a wide variety of techniques to reconstruct the environment used and affected by native peoples.

Outcome: Developing regionally appropriate methods for incorporating archaeological data into fire histories. A pilot study should precede development of protocols to integrate significant archaeological information with fire history studies. The pilot should examine the types of information most useful for developing accurate historic reference conditions and for providing management with data important to defining restoration goals and techniques.

RD&A: Develop appropriate research techniques and focus to use archaeological data and studies to promote accurate assessments of historic reference conditions and restoration goals.

BLM Science Priorities

Item #23 BLM Fire and Fuels Research Needs

Note: The Bureau of Land Management summarized these needs through Melanie Miller, fire ecologist and are presented as written by Melanie. Topics addressed are:

- **Salvage logging effects**
- **Weed invasion after fuels treatments**
- **Fuels mastication**
- **Hydrophobicity**
- **Hydrology in areas with conifer encroachment**
- **Predicting vegetative recovery after fire**
- **Fire behavior in live fuels**

Salvage logging effects

Are there ecological values or fuel management benefits to be gained from salvage? A stated reason for removal of dead trees is that once down on the forest floor, they increase fire hazard. The specific question is whether consumption of this wood in a fire results in a greater severity of fire than would have occurred under the natural range of variability to which the ecosystem adapted. This may not be an issue in ecosystems with long fire return intervals with a forest structure not significantly affected by fire exclusion. However, in many forest types that used to experience dry and mixed severity fire regimes, the tree density and surface fuel loading has become higher than under "natural" conditions, making the site conducive to lethal fires. It is thought that these fires can create a higher snag density over larger areas than would have occurred under the nonlethal or mixed severity fire that would have occurred in the past. The snags eventually contribute to postfire coarse woody debris levels that are much higher than would have been present under a natural disturbance regime. Surface fire severity that results from consumption of these fuels would also be higher than the sites would have experienced.

If there is a potential for increased fire severity, greater soil heating, more negative effects on understory recovery, and the creation of more safe sites for weeds, does this warrant removal of dead trees before they become fuel? How would the removal of all of this woody material, by salvage or by fire, affect site nutrient capital? In a mixed severity fire regime, how do you determine which sites have been affected by fire exclusion, and which are within the historic range of variability? Are these effects more or less of a concern in "managed" stands in which silvicultural manipulation has occurred, such as in thinned, second growth, or high-graded stands? How does any of this relate to soil characteristics, site productivity, or plant community? Given that plant communities on these sites have probably shifted many times with past climate change, does a short-term shift in fire regime matter at the larger scale?

Weed invasion after fuels treatments

Fuels treatments that result in exposed mineral soil, increased light levels, and temporary removal of competing native vegetation can create environments very suitable for weed establishment. What ecosystems, soils and treatment types are most susceptible to invasions by weedy species? Which weed species are most problematic in which community types? How long do they persist? Does persistence relate to ecosystem type, recovery of native vegetation, and site characteristics? Can we predict whether persisting species will pose a competitive threat to native species, or merely be present after a few years? This knowledge will help us determine when and if weed control is needed, and in designing fuel treatments in weed susceptible environments.

Fuels mastication

Fuels mastication changes canopy fuels to surface fuels, creating a new fuel type about which we know little. We may not have a good way to inventory them, because the different lengths and chunks of wood are not similar to the natural forest fuels for which the standard methods for fuels inventory were created. Since these fuel layers can be very different from natural fuels, we may need new wetting and drying algorithms, and experimentation to understand the relationship between their moisture content and their consumption. Significant amounts of smoldering combustion can occur in these fuels, leading to potentially higher surface fire severity, particularly during wildfire conditions, which would cause deeper soil heating over a larger percentage of the area. This soil heating could induce greater physical and chemical changes in soils, and higher plant mortality by killing tree roots, and buried plant parts with the capability to resprout.

There may be significant ecological issues associated with the presence of masticated fuels.
These effects will relate to the characteristics of the post-mastication fuel bed, its depth and the size class distribution of pieces of wood. This fuel bed will vary by plant community, tree and shrub species, their density, height and diameter, and treatment prescription. What happens to soil temperatures with the addition of a layer of insulating wood? What effect does the decomposition of masticated fuel have on the soil carbon/nitrogen ratio, and/or availability of other nutrients, and how long do these effects persist? Is there an effect on soil microflora and fauna, nitrogen fixation, and mycorrhizae? How does any change in soil nutrients affect the growth of on-site vegetation? Do masticated fuels inhibit the growth of vegetatively regenerating shoots, and seedling germination and establishment? Are there critical thresholds of masticated material beyond which effects are more extreme?

Hydrophobicity

The formation of water repellant soil layers in association with fire is assumed by many to be a common occurrence, and has been used to justify extensive postfire rehabilitation treatments. Significant erosion after southern California wildfires has been attributed to the formation of hydrophobic layers. However, the production of a water repellant layer can vary widely among fires with different heat regimes as well as with differences in soil characteristics, amount and type of organic matter, soil texture, soil moisture, and the type of vegetation that burns (DeBano 2000). How often do these layers form, and what specific fuel loading, fuel moisture and soil conditions are associated with their development? How does their formation relate to the natural hydrophobicity present in some soils? How does their formation relate to the pattern of fuel distribution on a site? What factors affect the persistence of water repellant layers? Can we estimate the likelihood of their development if we know soil type, fuel type, fuel loading, and the behavior and characteristics of a fire? If fuel and soil conditions lend themselves to the formation of hydrophobic layers during burning, can we design fire prescriptions under which these sites can be burned to manage fuels, without the formation of these layers? Does a fire that occurs in a deep layer of masticated fuels have an increased likelihood of causing hydrophobicity?

Hydrology in areas with conifer encroachment

There are significant acreages west of the Mississippi where conifers have moved into shrublands and grasslands, attributed to the exclusion of fire due to fire suppression and livestock grazing, and to climate change. Most notable are juniper invasion into sagebrush-grass in Oregon, Douglas-fir into central Montana grasslands; eastern redcedar in Oklahoma and Texas, and ponderosa pine in eastern Montana. A comparison of inventory data collected in eastern Oregon in 1936 and 1988 shows a five-fold increase in cover of juniper forest, which may eventually reach 6 million acres, a 13 fold increase (Gedney et al 1999). A study in southwest Montana (Heyerdahl and Miller 2004) showed that the distribution of vegetation has changed dramatically since 1855 from a former sagebrush/grassland with stable islands of Douglas-fir on fire-safe sites to an area dominated by Douglas-fir forest, with an associated loss of understory vegetation.

There is much more aboveground biomass on conifer dominated sites compared to the plant communities they have replaced. Trees are using and transpiring water that is no longer available to feed springs and streams, and maintain meadows. There has been anecdotal evidence that removal of trees causes recovery of water features, but not much research. Clayton Marlow, Montana State University, has been working with Lewistown BLM on a JFSP project in the Missouri River Breaks. He has documented higher water levels in wells in watersheds where prescribed fire has decreased the density of ponderosa pine and horizontal juniper, with the July groundwater table 50 and 70 cm higher in two small watersheds two years after prescribed fire, compared to unburned watersheds (Marlow 2005).

If sites are undisturbed long enough, understory vegetation can disappear. The 'Sagebrush Fire-fire Surrogates research project' will investigate thresholds of pinyon-juniper cover associated with understory die-off due to moisture competition. Management issues that are not primary research objectives include the loss of soil associated with absence of protective understory vegetation, and the watershed effects of fires in these stands where understory recovery will be slow or dominated by weeds. There are research questions specifically related to treatments to remove or thin invasive trees to improve water availability. Where will conifer removal most likely result in recovery of surface water? How does this relate to position in the watershed? How much of the tree canopy needs to be removed over how large an area? How does any increase in water availability after treatment relate to soil types, subsurface geology, and climatic characteristics?

Predicting vegetative recovery after fire

Postfire recovery of shrubs, forbs, and graminoids relates to postfire soil movement, soil nutrient status, and wildlife habitat. While models predict tree mortality caused by crown and stem heating, there are no quantitative models that predict recovery of understory vegetation. Many plants resprout from dormant or newly formed buds on roots, rhizomes, and root crowns, or reestablish from seeds on-site seeds. Some of these seeds require heating to scarify their seed coat, and may even need exposure to smoke or water that has leached through charred materials.

In order to predict the effects of fire heat on buried plant parts and seeds, we need better models for heat transfer below the surface. Current models estimate penetration of heat into mineral soil caused by burning of forest floor duff and/or woody debris. However, they don't estimate lethal temperature penetration into deep organic layers in situations where the entire organic layer is not consumed. This is particularly relevant to forests that have fairly deep duff layers, and it relates to organic soils anywhere. The models do not predict the heating of buried plant parts. Research questions include: what is the time/temperature relationship for lethal heating of buried plant parts, whether they are located in duff or soil layers? How much exposure does it take to kill a bud that is within a basal burl, or within a woody rhizome? How much heat can seeds absorb before they die? How does lethal heating of plant tissue relate to fire duration, soil temperature, soil moisture content, and mass and moisture content of the plant tissue? Field experimentation that obtains data relevant to these questions could provide the basis for a model that a manager could use to estimate vegetation recovery after a wildfire, and to develop an optimum prescription for a prescribed fire.

Bunchgrass mortality can vary among fires, and among species, and it relates to the amount of heat received by basal buds and meristems. These growing points are located at various depths below the surface of the bunch, which in itself has different fuel characteristics related to blade width, basal density, biomass, plant surface area, and live to dead fuel ratio. Flaming residence time likely relates closely to wind speed and fine fuel characteristics, but the factors that determine ignition and sustained combustion of dense fuels within the base of bunchgrass plants are not documented. Sustained combustion in basal material may only occur if the plant had a dead center that could be ignited by flames. Postfire mortality of needlegrass plants was observed to be low after fires that occurred at high wind speeds (Petersburg 1989), and it was theorized that flaming residence time was too short to raise basal material to ignition temperature, or to transfer lethal temperatures to basal buds.

There are no current guidelines to predict mortality based on damage, nor to relate damage to the conditions under which a fire occurs. If there is a relationship between smoldering combustion, meristem mortality, and the presence of a dead center, there may be higher likelihood of plant mortality when fire occurs in stands of older plants. Bunchgrass plants in association with shrubs may be more likely to receive enough preheating to raise dead basal materials to ignition temperature. If higher windspeeds are more conducive to plant survival in some situations, the low windspeeds under which we usually conduct prescribed fires may have a more negative effect. Decisions about fire treatment prescriptions, and the need for postfire rehabilitation would be enhanced if we knew more about causes for variable fire effects in this widespread group of plants.

Fire behavior in live fuels

The Rothermel fire spread model does not well account for the presence of live fuels (Andrews 2006, personal conversation). We lack knowledge of the characteristics of live fuels, such as seasonal moisture cycles, its relationship to phenology, the curing process in grasses, the levels and types of volatiles, with particular respect to evergreen compared to deciduous species, and live to dead ratios among different species as they age. We also know little about fire behavior in live fuels, the effect of volatiles on fire spread and intensity, the interaction of foliar moisture and fire behavior, the spread and combustion in these deep beds of finely divided fuels, and how live fuels affect combustion in intermixed dead fuels. Is the high degree of flammability in such fuel types as California chaparral because of fuel geometry, live/dead ratios, the presence of volatiles, or interactions of all of these variables? There is a major disagreement over the value of fuel treatments in chaparral, because it is argued that these types can burn again not that many years after treatment. The possibility that fires in young stands may have much less severe effects has not been well investigated.

These two questions are not from BLM, but I have run out of summarization energy.
I will try to honor them by larger type and my thanks to you for reading this lengthy and I hope enlightening summary of what managers and practitioners need….

Riparian Habitat - Eastside: Specialists continue to want to <u>not</u> treat riparian management zones or if treated, only lightly. Riparian management areas then become "wicks" for spreading fires and often experience the most intense fire conditions depending upon geographic postions. What can we really do to protect riparian management zones in dry, fire prone environements?

How do we meet mutiple resource needs from high risk habitat? (For example, habitat requirements for Northern Spotted Owls, Great Gray Owls, Northern Goshawks and at the same time dealing with bark beetles, fire prone stands, and community protection.)

But wait, I saved the best for last…

Southeastern Region (R-04)
U.S. Fish and Wildlife Service
April 14, 2006

Question or Problem #	Question & Background
1	At what (quantitative) fuel and climatic condition thresholds do woody wetland fuels (on deep combustible organic soils) cease being a natural barrier to fire spread, and become a significant contributor to that spread and extreme fire behavior? What are the most practical means that managers-practitioners can use to monitor and predict when these thresholds will be reached. A disproportionate share of USFWS-managed land is wetland, dominated by woody plants occurring on deep organic soils. These fuels can be difficult to ignite, but once they do extreme fire behavior and resistance to control becomes the norm. These fires also have a bad habit of exiting the wetland interior and moving into adjoining uplands where wildland-urban intermix/interface conditions are common. The largest and most expensive wildland fires in the southeastern U.S. since European settlement burned in these woody wetlands, yet we still have only a rudimentary understanding of what these threshold levels are how to monitor them cost-effectively.
2	Can we integrate the existing plethora of fire behavior prediction tools and those for predicting and estimating smoke dispersal, emissions and concentrations (and their related impacts on visibility and human health) that are scaleable as to both 3-D space and time intervals? Throughout my nearly 30-year federal agency career, I've longed to just one day sit at my desk/in my vehicle with a single, trusted, and integrated software suite (e.g. MS-Office Suite idea) make those projections or examine the appropriate "what if" scenarios for my specific site, landscape or area of interest over a time interval that is relevant. It seems most individual components of such a suite are in-hand or within reach, but are poorly linked at best so I either invest no time to use them, or I spend way more time manipulating input-output file formats or re-typing the same inputs 8 different times than I do considering what significance the outputs have to the fuels/fire management decision confronting me.
3	Is there any kind of synthesis of scientific knowledge about the process and conditions by which deep organic soils (histosols) ignite and combust? What are the most practical current tools for monitoring those conditions and what new knowledge and tools are in development by which tomorrows managers may more accurately predict and assess when a "peat-fire" is likely to result? When duff or "peat" will and won't ignite and continue to burn is vital to being able to avoid air quality episodes, and managing fuels and fires within an range of "severity" appropriate for the site/landscape being managed. With the National Fire Severity Atlas and LANDFIRE fine-scale FRCC initiatives now well underway, having this knowledge enhancement will vastly improve manager's ability to interpret present, and predicted departures from or changes in past fire severity. Along our Gulf coast marshes, the gap in our knowledge interaction between fire, subsidence, and sea-level rise as contributors to the breakup/loss of these marshes took on particular prominence in the aftermath of the 2005-2006 hurricane disasters, and is certain to re-emerge again in future years. Inland just slightly from these protective marshlands are hydric and mesic forest areas with deep surface organic layers where the decades long fuel arrangement and continuity changed radically literally overnight, and is now being followed drought conditions. What will the nature of new fires over the next 10-50 years be in this vast, hurricane-altered region be in terms of fire duration, intensity and severity, fire behavior, smoke and emissions, and other post-burn effects on soil, water, flora and fauna as the heavy fuels in these fuelbeds decompose? What will the contribution to these be from combustion of the surface organic component of the soils?
4	What's being done to provide field managers with one-stop-shopping "Fire Depot" from their desks or vehicle to find mission-critical tools, information, data, examples and case studies from. Manager's tell me they don't need anymore new tools to consume their time, until they can get better synthesis, filtering and points of entry to wade into the enormous volume now out there (thanks to NFP and IJFSP funding). They are currently unable to keep current or proficient with what is already "out there", let alone able to invest in the "learning curve" that comes with procuring it. They must spend less time locating, receiving and learning and processing their particular mission-critical information and tools so they can spend more time at their home units applying fuels treatments to their piece of dirt, in a more strategic and cost-efficient manner than they now do.